Muon Design Note #08

SUBSYSTEM: [X] CCM [ ] CVM [ ] Cryoplant

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TITLE: Chicago Cyclotron Magnet (CCM) 1985 Run Summary

RUN SUMMARY

The CCM cooldown began on 8/10/85. Shortly after beginning the nitrogen precooling it was noticed mistakenly that the temperature of the coils was near 32°F. The precooling was stopped, because it was feared that somehow water had been frozen out on the coils. The problem was rectified when it was determined that the current going through the coils was not 100 milliamps but some lower value because of a 600 ohm shunt that was placed in parallel across the coils. The coil temperature is determined by dividing the voltage drop across an individual coil by the current to get the coil resistance and then this resistance is looked up in a graph to determine temperature. The precooling with nitrogen took 5 days and was completed on 8/15/85. The CCM coils were soaked at liquid nitrogen temperature for 4 days. The nitrogen precooling rate for the 1985 run, Fig. 1, was very similar to the cooldown rate from a previous run shown in Fig. 2.

During the nitrogen precooling, helium gas was introduced into the vacuum space twice, both times there was no indication given by the leak detector that was monitoring the vacuum shell of a leak. The helium was introduced approximately one-quarter of the way through during the precooling and when the precooling was completed.

The columns and coils moved approximately the same distance with temperature as they did in previous runs. A plot of column and coil motion with temperature for the 1985 run and three previous runs is shown in the 1985 CCM run data book. The only appreciable difference noted during this run was that the upper coil columns moved more uniformly this run then in previous runs.

The nitrogen was removed by initially blowing it out through a copper tube to the outside. The final removal of the nitrogen was done by pumping and purging with helium followed by a helium flow purge. The initial pump down was carefully watched, recording vacuum with time, to ensure that there was no liquid nitrogen remaining in the coils. The nitrogen removal began on 8/19/85 and was completed on 8/20/85.

The helium cooldown began on 8/20/85 and was completed on 8/21/85. The lower coil became superconducting on 8/21/85 at 6:00 a.m. and the upper coil superconducting on 8/21/85 at 10:00 a.m.

The coils and columns moved as they had in previous runs.

The coils had a measured leakage current approximately ~200 microamps at a hypot voltage of ~100 volts when emersed in liquid helium. Comparing these results with a previous hypot results from a past run of 500 volts and leakage current of 0.05 microamps it was determined that somehow the coil had a lower resistance path to ground. The room temperature hypot results showed no grounding of the coils. It was feared that the coils had shifted and shorted out during cooldown. After removing all the instrumentation cables, the power cables and drying out the instrumentation feed through on the top hat the hypot voltage could be increased and the leakage current became unmeasurable. The final hypot results where 500 volts and leakage current of $\leq$0.05 microamps.

Before power testing it was decided to be absolutely sure that plenty of helium was present in the cryostat to ensure no operational problems with the magnet. The CCM has three individual 18" long AMI liquid helium probes for this purpose. Two of the helium liquid level probes (coil probes) have their ends situated just above the bottom of the upper coil. The remaining helium liquid level probe (reservoir probe) has its end situated just above the bottom of the liquid helium reservoir, the difference in height between the two above mentioned end points is approximately eight inches. During the initial electrical checkout it was found that the reservoir probe was shorted to ground. For the 1985 run the spare or coil probe was used. At the time it was common knowledge that the spare probe was a reservoir probe. After filling the coils with helium the two probes indicated the same height of helium. This could not be if our common knowledge was correct, the probes should indicate values that differ by eight inches. Was it possible that one of the probes was bad or perhaps both probes were bad? After some researching and experimentation it was determined that the CCM actually has two coil probes not two reservoir probes.

To double check the above answers, it was decided to fill the CCM until the probes indicated 10 inches of helium. This would indicate that there was 2 inches in the reservoir. The amount of helium added to the magnet was recorded as a function of liquid level. It was seen that the liquid level went up very quickly for the first 8 inches then tapered off quickly for the final 2 inches. It takes many more liters of helium to raise the liquid level one inch in the reservoir as compared in the coil package. With this result it was certain that both probes were coil probes.

Power testing began on 8/27/85 and ended on 8/30/85 after reaching 875 amps. Right after the 20 amp power test was done to check out the interlock system which worked as designed, Tom Fitzpatrick noticed that the power supply was acting funny. It was putting out a large amount of current (1000 amps) when it was being asked for a small amount ~20 amps. The problem was traced to some shorted control cables, which were later fixed. During charge up no large imbalance spikes were seen. The strain and stress versus current experienced by the columns was similar in magnitude and trend as in the 1981 run. While the power testing was in progress the Harvard group was assembling their detector using large thin steel sheets on the north end of CCM. These sheets were being moved using the crane. When charging up to 650 amps the magnet dumped itself unexpectedly because of a sudden jump in the imbalance voltage. The second time the magnet was being charged to 650 amps everything went smoothly. The reason postulated why the magnet tripped was because the magnetic field was disturbed causing eddy currents which inturn produced an imbalance in the coils. The disturbance being caused either by the motion of the steel plate, starting or stopping of the crane, or by the crane hook. The magnet also tripped due to an imbalance voltage spike once it had reached 800 amps for the first time and was sitting at this current for a half minute. For the first few charge ups beyond 800 amps the inhibit button had to be held in until the power supply had quieted down when it switched from voltage mode to current mode.

If the inhibit button was not held in while powering up beyond 800 amps the CCM would have tripped itself off. After the magnet was ziptracked, Tom Fitzpatrick ran several tests (ramping the magnet current) to check out the power supply, he could not get the power supply to act up. There is some kind of glitch occuring within the power supply and it is not consistent enough to be found. In the past this power supply has had problems. Once the magnet had reached full operating current several technicians walked around the magnet with wrenches to check the strength of the magnetic field. It was found to be very strong where it spills out of the gap and dies off quickly as you move away from the gap. As this activity was going on it was noticed that the imbalance voltage was jumping around. From this we concluded that the CCM is concious of small pertubations of the magnet field. The fluctuations where in the order of 10 millivolts, 75 millivolts being the trip point. Even shaking gas cylinders that are inside a rack which is attached to the magnet produced spikes of this magnitude.

The CCM was ziptracked from 9/3/85 to 9/6/85. The magnetic field values at 670 amps where within a few percent of the values from the previous ziptrack run of 1981.

The magnet was warmed up very slowly. The helium inventory was allowed to boiloff while keeping the nitrogen shield cold. Once the helium boiloff went to zero the shield flow was turned off. It took from 9/7/85 to 10/1/85 to warm up the magnet from liquid helium temperature to room temperature. There were no problems experienced with the column movement as the CCM warmed up.

The only unexpected occurrance during warm up was that the magnet vacuum had gone from its initial value of ~80 microns before cooldown to ~275 torr after warm up. It has not been determined why this happened.

PRESENT STATUS

To remove the present short in the coil probe, its lemo connector is being replaced.

The CCM power supply is being left as it is. I have been assured by John Stoffel and Tom Fitzpatrick that there is nothing seriously wrong with the power supply. If it should fail they feel that it can be fixed or replaced in a short time.

The CCM vacuum shell was thoroughly leak checked during the month of February 1986, as an attempt to find all the existing leaks. No new leaks were found. The only leaks that were found are as follows:

1. in the bellows connection for lower column number four,

2. the thermocouple feed throughs upper and lower coil and

3. the upper coil north coil position indicator.

The bellows leak has been repaired using epoxy. The thermocouple feed throughs will have a coffee can placed over the old feed throughs and welded in place. This coffee can will have a new type of homemade feed through that will not leak. If it does leak it is designed to be easily replaced. The coil positioner leak has been repaired by using epoxy. The next run will indicate how successful the repairs were.

REVIEWED BY

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Name   Date

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FIG 1. COOLDOWN RATE FOR 1985 CHICAGO CYCLOTRON RUN

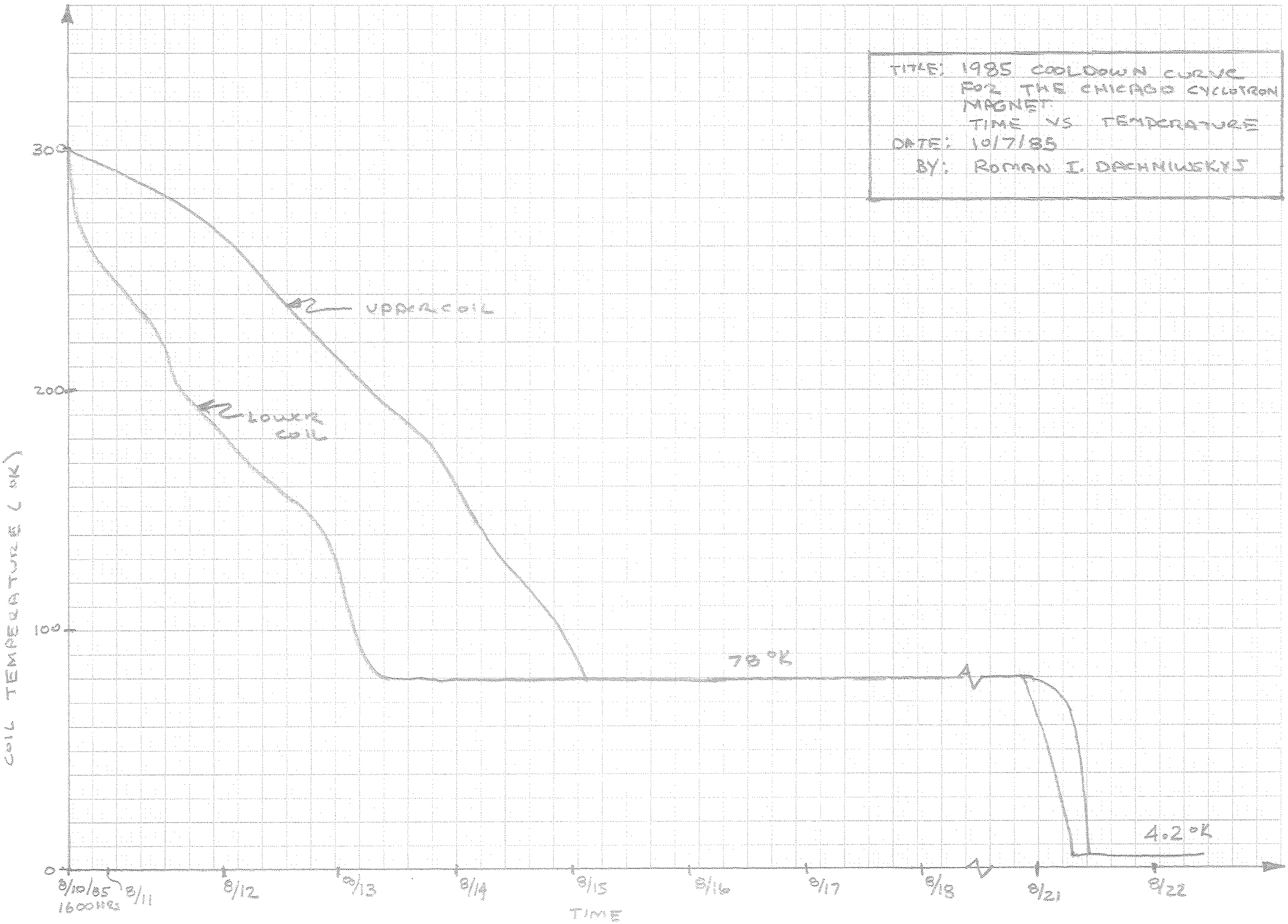

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FIG 2. COOLDOWN RATE FOR PREVIOUS CHICAGO CYCLOTRON RUN